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Evaluation of common carotid and vertebral arteries flow volumes in patients with ankylosing spondylitis

Arterial flow volume in ankylosing spondylitis

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Abstract

Aim: The aim of this study was to compare carotid intima-media thickness (IMT) and common carotid artery-vertebral artery flow volumes in ankylosing spondylitis patients with age and sex-matched healthy controls.

Materials and Methods: Fifty patients with ankylosing spondylitis (study group) and 50 healthy volunteers (control group) were included in the study. At first, carotid intima-media thickness (IMT) measurements were performed in supine-neutral position by B-mode ultrasonography (US). Afterwards, common carotid and vertebral artery flow volumes were calculated by Doppler US in the neutral, right rotational, and left rotational positions.

Results: Carotid IMT was significantly higher in the study group according to the control group (p=0.001). The common carotid artery (CCA) and vertebral artery (VA) flow volumes in the neutral position were similar between the two groups. There was no significant difference in CCA flow volumes between the groups in right and left rotational positions (p>0.05). Right vertebral artery and total vertebral artery flow volumes in the right rotational position were significantly lower in the study group (p=0.022 and p=0.005 respectively). In the left rotational position, left vertebral artery and total vertebral artery flow volumes were significantly lower in the study group when compared with the control group (p=0.001).

Discussion: In our study, carotid IMT was significantly higher in patients with AS compared to healthy controls. Besides, significant volume decreases in vertebral artery flow volumes were detected in the study group in rotational positions.

Keywords

Ankylosing Spondylitis; Doppler Ultrasonography; Flow Volume; Intima-media Thickness

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Introduction

Ankylosing Spondylitis (AS) is a chronic inflammatory disease that primarily involves sacroiliac joints and axial skeleton. The main extraarticular structures affected in AS are the eyes, intestines, lungs, heart, skin, and kidneys [1]. Increased risk of cardiovascular disease and atherosclerosis has been reported in some chronic rheumatic diseases, especially in rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE) due to a widespread systemic inflammatory response [2,3].

Measurement of intima-media thickness (IMT) of the common carotid artery is a useful marker in the diagnosis of early atherosclerosis, and the relationship between IMT and subclinical atherosclerosis in RA has been demonstrated [4]. However, in some studies on AS patients, carotid IMT values were higher than the control group, and in some other studies, it was reported that there was no significant difference compared to the control group [3,5-8].

In the literature, we did not find any studies examining the common carotid artery (CCA) and vertebral artery (VA) flow volumes in AS patients. As known, vertebral column involvement is prominent in AS and syndesmophytes and enthesopathic changes occur in joints and soft tissues. In particular, we thought that VA flow volume may be affected because of its course in the transverse foramina.

This study aimed to compare carotid IMT, a marker of subclinical atherosclerosis, in AS patients with healthy volunteers. In addition, we aimed to evaluate how CCA and VA flow volumes may change in AS patients compared to healthy controls.

Material and Methods

Subjects: The data of the patients who were diagnosed as AS in the physical medicine and rehabilitation clinic between September and November 2014 were collected retrospectively from the hospital database. All patients were questioned about previous neck trauma or surgical histories of the vascular structures in the neck region. Patients with comorbid conditions such as dyslipidemia, hypertension, diabetes mellitus, cerebrovascular disease, renal failure, peripheral vascular disease, and smoking were excluded from the study. In addition, a patient with vertebrobasilar insufficiency, a patient with 70% stenosis in the proximal left internal carotid artery, and a patient with severe cervical hernia were excluded. Fifty AS patients (25 male, 25 female) with appropriate conditions for the study were included in the study group, and 50 healthy volunteers (25 male, 25 female) were included in the study as the control group. All patients in the study group met the modified New York criteria for AS [9]. Our study was approved by the Van Yüzüncü Yıl University Ethics Committee. After being informed of the procedure, written informed consent was obtained from all individuals.

B-mode US and Doppler US examination: The US device (Philips, HD11, Andover MA / USA) with a 7.5 MHz linear transducer was used with the "carotid" preset option. The patients were extended to the right side of the examiner in a supine-neutral position. In this position, the carotid IMT was measured by B-mode gray-scale US at 2 cm proximal to the CCA bifurcation. A typical double-line image representing the intima-media layer was obtained, and three separate measurements were made on the right and left CCA. The mean value of the six measurements was defined as the IMT value of each subject.

Following B mode US examination, Doppler US was performed. Firstly, CCA flow volumes were calculated by keeping the Doppler angle at 60 degrees without causing significant compression at 2 cm proximal to CCA bifurcation in the supine-neutral position. Arterial flow measurements were automatically calculated by the software of the sonography device after manually entering the cross-sectional diameter and time-average velocity.

VA flow volumes were also evaluated at the same level between the transverse foramina by moving the linear transducer towards posterior. The patients were rested for three minutes before right and left rotational position measurements. In rotational positions, the neck was turned to the right and left, with the mandibular condyle at the level of the sternum, and arterial flow volumes were measured as described above. B-mode US and Doppler US examinations were performed by a single radiologist (S.Or.) who had five years of expertise in conventional and Doppler US.

Statistical Analysis: Descriptive statistics for the studied variables were expressed as mean±standard deviation, minimum and maximum values. Firstly, the normal distribution of parameters was confirmed by the Shapiro-Wilk test and then parametric statistical analysis was performed. One way analysis of variance (ANOVA) was used to compare the mean values of the groups for continuous variables. To determine the relationship between these variables, Pearson correlation coefficients were calculated separately for each group. The Chi-square test was used to determine the relationship between groups and categorical variables. Statistical significance was set at $p<0.05$. SPSS statistical package program (ver.13) was used for data analysis.

Results

Fifty patients with AS (25 males, 25 females, mean age 32±9.8 years; range from 18 to 59 years) and 50 healthy volunteers (25 males, 25 females, mean age 32±9.3 years; range from 21 to 58 years) were included in the study. There was no statistically significant difference between the two groups in terms of mean age (p=0.287). The mean duration of the disease in AS patients was 6±3.8 years.

Table 1. Arterial flow volume and carotid IMT values in the neutral position

	Study Group		Control Group		P
	mean±SD	Min.-Max.	mean±SD	Min.-Max.	
Right CCA flow volume	845±849	439-6687	752±152	468-1271	0.445
Left CCA flow volume	730±126	426-1030	745±165	455-1300	0.600
Total CCA flow volume	1575±864	1040-7455	1498±251	977-2232	0.541
Right VA flow volume	123±42	34-229	138±61	22-299	0.147
Left VA flow volume	129±45	43-273	124±55	44-320	0.679
Total VA flow volume	252±46	176-385	263±67	88-471	0.332
Total CCA+VA flow volume	1827±884	1348-7840	1761±247	1215-2411	0.609
Carotid IMT	0.60±0.07	0.48-0.82	0.55±0.06	0.44-0.82	0.001

CCA: common carotid artery, VA: vertebral artery, IMT: intima-media thickness

Table 2. Arterial flow volume values in the right rotational position

	Study Group		Control Group		P
	mean±SD	Min.-Max.	mean±SD	Min.-Max.	
Right CCA flow volume	742±145	435-1000	733±148	452-1271	0.763
Left CCA flow volume	780±119	541-995	779±175	412-1411	0.961
Total CCA flow volume	1523±231	1088-1951	1513±275	864-2682	0.839
Right VA flow volume	111±45	29-274	155±123	31-864	0.022
Left VA flow volume	133±46	25-242	150±56	29-264	0.089
Total VA flow volume	244±55	150-369	305±138	141-1093	0.005
Total CCA+VA flow volume	1768±255	1265-2247	1819±325	1181-3000	0.387

CCA: common carotid artery, VA: vertebral artery

Table 3. Arterial flow volume values in the left rotational position

	Study Group		Control Group		P
	mean±SD	Min.-Max.	mean±SD	Min.-Max.	
Right CCA flow volume	862±117	512-1050	778±174	493-1310	0.060
Left CCA flow volume	780±123	451-1030	779±176	463-1280	0.990
Total CCA flow volume	1642±213	963-1974	1558±266	1060-2255	0.083
Right VA flow volume	126±46	33-258	141±72	43-394	0.218
Left VA flow volume	87±20	45-142	142±80	32-553	0.001
Total VA flow volume	214±42	132-417	284±97	134-603	0.001
Total CCA+VA flow volume	1896±226	1203-2341	1854±313	1261-2554	0.449

CCA: common carotid artery, VA: vertebral artery

Comparative US results are summarized in Tables 1, 2, and 3. Carotid IMT was significantly higher in the study group (0.60±0.07 mm) compared with the control group (0.55±0.06 mm) (p=0.001).

The CCA and VA flow volumes in the neutral position were similar between the two groups. There was no significant difference between CCA flow volumes in right and left rotational positions between the groups (p>0.05). The right vertebral artery and total vertebral artery flow volumes in the right rotational position were significantly lower in the study group (p=0.022 and p=0.005 respectively). In the left rotational position, the left vertebral artery and total vertebral artery flow volumes were significantly lower in the study group when compared with the control group (p=0.001).

There was no statistical significance in other parameters.

Discussion

Ankylosing Spondylitis is a chronic inflammatory disease primarily involving the sacroiliac joints and spine. There are common extra-articular manifestations such as cardiovascular involvement in AS. The mortality rate in AS patients is 1.6-1.9 times higher than the normal population and cardiovascular involvement is estimated to account for 20-40% of this rate [5,10,11]. The mechanism of association between AS and cardiovascular involvement is not fully understood. However, it has been reported that systemic inflammation and autoimmune response play a primary role in the pathogenesis of atherosclerosis and chronic systemic inflammation contributes to increased mortality and morbidity [5,10].

Carotid IMT measurement with high resolution B-mode US is a non-invasive method and an important marker for the assessment of early subclinical atherosclerosis [12]. In our study, carotid IMT values measured in AS patients were significantly higher than healthy controls. We attribute this statistically significant difference to subclinical atherosclerosis described in the literature. In studies, carotid IMT values in AS were higher than in healthy controls and this finding was associated with subclinical atherosclerosis [5,6,10]. However, Choe et al. [7] and Sari et al. [8] found no significant difference in carotid IMT values between the AS patients and control groups. Yuan et al. [1] evaluated 24 articles in a meta-analysis study and found significantly increased carotid IMT in AS groups compared to healthy controls, and stated that this was related to subclinical atherosclerosis in AS.

To the best of our knowledge, there were no studies in the literature examining the flow volumes of CCA and VA in AS patients. In our study, we measured bilateral CCA and VA flow volumes and total arterial flow volumes in neutral, right and left rotational positions. We interpreted the absence of significant changes in CCA flow volumes to autoregulation mechanisms that further protect the anterior circulation and provide haemodynamic balance. We observed that the right VA flow volume in the right rotational position and the left VA flow volume in the left rotational position were significantly lower in AS patients compared to the control group. Likewise, we measured the total VA flow volume in the right and left rotational positions significantly lower in the study group than in the control group. The significant difference in VA flow volume between the two groups in the right and left rotational positions may be due to possible syndesmophytes and enthesopathic changes that cause partial compression of VA (due to the anatomical course of the vertebral artery in the cervical vertebral column) in AS patients. Because syndesmophyte formations are determinant in structural damage and sometimes they can lead to complete fusion of axial skeleton and even peripheral joints. In addition, changes such as vertebral erosions, sclerosis, inflammatory lesions, and fat tissue dysplasia can be seen in the spine [13,14]. Small sample size is the most important limitation of our study. Besides, the lack of correlation of the data obtained in our study with laboratory values such as erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and cholesterol can be considered as a limitation.

Conclusion: In this study, carotid IMT was significantly higher in AS patients compared to healthy controls. We did not find any significant difference in CCA flow volumes between study and control groups. However, significant volume decreases in VA flow volumes were detected in the study group in rotational positions. We attribute this finding to possible joint and soft tissue changes that may affect VA in AS patients. Further studies are needed to confirm our findings.

Scientific Responsibility Statement
The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement
All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest
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